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Application of Hedonic Dynamics Using Multiple-Sip Temporal-Liking and Facial Expression for Evaluation of a New Beverage

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Running head: **Hedonic Dynamics Using Multiple-sip Temporal-liking and Facial Reactivity to Taste**

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Abstract

Drinking and eating are not a matter of a single sip or bite. Dynamic data gathered from multiple sip or bite, seem to be more reliable than simple sip/bite evaluation. However, methodologies and analyses based on multiple sips/bites have received little attention until recently. The present study tested an innovative approach to measure the temporal changes in acceptance. It combines multiple-sip temporal-liking measurements (MSTL) with implicit taste reactivity using facial pattern expressions at different time points, for evaluation of a new beverage. Seventy-three consumers (35 females and 38 males) evaluated acceptance during 60 seconds, drinking three sips, with each sip every 20 seconds. The consumers' faces were filmed by a camera during the test session in order to analyze facial affective reactions. The results of the present paper show that MSTL modality allows seeing temporal changes in the acceptance of the beverage. Parameters analyzed (maximum intensity (I_{max}) and area under the curve (AUC) in self-reported response curves presented variation through successive sips. The self-rated liking increased from the first sip to the third. In the same way facial expressions also showed a change over time during successive sips. In this case, the basic emotion of disgust, unpleasantness-related Action Units (AUs; AU 26 and AU 15) and negative valence showed a decrease from the first sip to the third one. It was observed that negative facial reactions are greater than the positive facial reactions in intensity.

Keywords: Facial expression; Healthy beverage; Multiple-sip modality; Temporal acceptance; Hedonic

1. **Introduction**

In this paper temporal aspects of consumer acceptance during consumption are examined. Temporal consumer acceptance is an issue that has recently gained interest (Delarue & Blumenthal, 2015) There are different ways to measure consumers' hedonic response to food in a dynamic perspective during a one bite/sip consumption event that have been suggested. Hedonic Time-Intensity (TI) and Multi-Attribute Time-Intensity methods have been used to provide information about the onset and decay of the hedonic attributes, its duration and its maximal intensity (e.g., Delarue & Loescher, 2004; Kuesten, Bi, & Feng, 2013; Methven, Rahelu, Economou, Kinneavy, Ladbrooke-Davis, Kennedy et al., 2010). The Temporal Dominance of Sensations (TDS), Temporal Dominance of Emotions (TDE) and Temporal Drivers of Liking (TDL) approaches, consist of identifying dominant sensations/emotions which are responsible for the liking or disliking of a product, until the perception ends (e.g., Jager, Schlich, Tijssen, Yao, Visalli, De Graaf & Stieger, 2014; Sudre, Pineau, Loret & Martin, 2012; Thomas, Visalli, Cordelle & Schlich, 2015).

Sudre et al. (2012) adapted TDS approach to investigate the temporal aspects of hedonic assessment, replacing the attributes by a 7-point liking scale. Consumers recorded temporal changes in their liking by clicking on a button corresponding to the above 7-point liking scale. With this procedure, consumers were not asked to constantly manipulate a cursor as for Time-Intensity, but just to focus on their liking change. However, the consumer decision to change the liking level during test is more an interval measure than a continuous quantification. Thomas et al. (2015) applied TDS to measure temporal liking, but they introduced a change in order to encourage the subjects to re-evaluate their liking. The blackened box corresponding to their liking score is turned back to white after 3 seconds. Subjects were instructed to re-evaluate their liking at these moments, and clicking the same box as before if they do not perceive any change in liking. The modification to the TDS scale brings it closer to the Time-Intensity register.

These approaches take into account one sip of the product. However, consuming a beverage is not a matter of a single sip as it implies dynamic physical, sensory, physiological and psychological phenomena with time (Delarue & Blumenthal, 2015; Galmarini, Symoneaux, Visalli, Zamora & Schlich, 2015; Sudre et al., 2012). In order to get a more realistic description of the products' sensory and hedonic experience, dynamic changes over several sips in perception and acceptance of the drink should be considered. In this sense, previous studies have reported that small differences in the sensory profiles of products only become noticeable after repeated tasting; and changes in acceptance may be associated with small variations in the sensory properties over time (Köster, 2009; Köster, Couronne, Léon, Lévy, & Marcelino, 2002; Stein, Nagai, Nakagawa, & Beauchamp, 2003; Zandstra, Weegels, Van Spronsen, & Klerk, 2004). For instance, the use of multiple-sip Temporal Dominance of Sensations have been able to identify differences among sweeteners which had not been detected using classic sensory measurements averaged across time (Zorn, Alcaire, Vidal, Giménez & Ares, 2014). To our best knowledge, no previous studies have applied multiple-sip methodology to the temporal liking assessment of beverages.

The focus of the present study was to test an improved method of TI, called multiple-sip temporal-liking (MSTL), based on scoring liking at predefined time-points during several sips (using computerized time-intensity method) to evaluate a new healthy beverage.

In recent years, there has been a growing interest in developing new functional beverages with special characteristics and health properties. Fortification of drinks offers a convenient alternative to contribute to a better nutritional quality of the population and a better balance in the daily diet. In particular, fortified drinks elaborated with wine polyphenols have received considerable interest for their presumed beneficial effects including antioxidant, anticarcenogenic, anti-inflammatory, hypotensive or even anticoagulant properties (see Arranz, Chiva-Blanch, Valderas-Martínez, Medina-Remón, Lamuela-Raventós, & Estruch, 2012, for a review). It has been shown that small daily intakes of wine can reduce the risk of coronary heart disease and atherosclerosis, this benefit is ascribed to the antioxidants properties of the phenolic compounds (Díaz et al., 2012; Radovanovic & Radovanovic, 2010; Mazza, Fukumoto, Delaquis, Girard & Ewert, 1999; Renaud & de Lorgeril, 1992) which differ from those found in grapes.

However, there are some drawbacks in wine consumption associated with the ingestion of alcohol: a) consumption must be moderate (i.e. 1-2 glasses per day) in order to avoid alcohol related diseases, and b), many people, either by ethnical, social or religious reasons do not consume wine. Recently a new dealcoholized powder was obtained from freeze-drying red wine which contained the polyphenols but without the alcohol (Sánchez, Baeza, Galmarini, Zamora & Chirife, 2013; Galmarini, Maury, Mehinagic, Sánchez, Baeza, Mignot, Zamora & Chirife, 2013; Rocha Parra, Galmarini, Chirife & Zamora, 2015). It is to be noted that 400 mL of this reconstituted beverage contains about the same amount of wine polyphenols that a glass (100 mL) of red wine.

In order to complete our assessment of the temporal changes in acceptance of this beverage, repeated liking measurements were combined with implicit taste reactivity methodology using facial expression patterns. It is believed that facial expression analysis may aid in finding rapid, uncontrollable micro-expression responses that influence acceptance and preferences (Leitch, Duncan, O'Keefe, Rudd & Gallagher, 2015). Furthermore, facial expressions appear to reveal more accurate hedonic response to beverages as they reflect the affective core process without contamination from higher-order appraisal processes (e.g., Berridge, 2000; Havermans, 2011; Pham, Cohen, Pracejus, & Hughes, 2001).

The aim of present study was to measure the temporal changes in acceptance with repeated liking measurements (explicit measures), combined with taste reactivity methodology using facial expressions (implicit measures) during consumption of a new healthy red wine-based powder beverage. Besides the two modes (explicit and implicit) in multiple-sip methodology were also used for exploring whether gender differences affected temporary acceptance.

2. Materials and Methods

2.1. Participants

The study was carried out with 73 consumers, recruited from the Pontificia Universidad Católica Argentina, based on their frequency of consumption of fruit juices (at least 2–3 times a week) and red wine (at least once a week). The whole population was homogeneous, consisting of 35 females and 38 males; aged 18 to 41 years old (22.3 ± 3.2, mean ± standard deviation). The procedure was conducted in individual computerized booths and the participants' faces were filmed. Participants were informed about the purpose of the study and that the experimental procedure would be video recorded. All the subjects performed the tests in one session, signed an informed consent form and they were not compensated for their participation. The study was approved by the Ethics Committee of the Pontificia Catholic University of Argentina.

2.2. Samples

The two formulations used for the present work, called 35-4 and 40-5, were selected from a previous study (Rocha Parra et al., 2015) considering their different but highest acceptance ratings (6.1 ± 1.7 and 6.6 ± 1.3; $p<.05$) measured with a 9-point category scale in 144 consumers of both sexes, but without previous significant gender divergences using the simple-sip methodology. The formulation 35-4 was obtained by the combination (for one liter of reconstituted drink powder) of the 35g of wine powder + 4 g of commercial sweetener (cyclamate 5700 mg/100 g; saccharin 2000 mg/100 g), and 40 g of wine powder + 5g of commercial sweetener for the formulation 40-5. The formulations had the same concentration of raspberry aroma (0.01%, Symrise, Argentina) and thickeners (0.20%, Guar gum, Gelfix, Argentina) in both samples. The wine powder was obtained by freeze drying the wine according to a method previously described by Sánchez et al., (2013). The wine used was *Cabernet Sauvignon*, "Postales del Fin del Mundo" (*Bodega Fin del Mundo*) from a cold climate wine growing region (Neuquén province, Patagonia region, Argentina) with an original alcohol content of 13.7% in average and a pH of 3.8 (vintage 2013, aged in oak). Carbohydrates used as drying aids for encapsulation were a mixture of Maltodextrin (Dextrose Equivalent 10 (MD10) provided by Productos de Maíz S.A., Argentina) and Arabic gum (provided by Gelfix, Argentina). The solution of wine + carbohydrate was freeze-dried at room temperature in a FIC Ll-I-E300-CRT freeze dryer (Rificor, Argentina). The powder obtained had 3% moisture content and about 1400 mg polyphenols/ 100 g.

The samples provided to consumers were rehydrated the day of tasting and served in 10-ml transparent plastic cups at 15º C and encoded with three-digit random numbers to record the sample.

2.3 Preliminary testing

In order to design the timing between sip, a preliminary test was made with 16 participants (13 women and 3 men) who evaluated one sip of both samples during 30 sec by Time-Intensity (T-I) methodology taking into account the Taylor and Pangborn's (1990) results, in which the maximum levels of liking were observed at 20-30 sec after the placement of the sample in the mouth. The results showed that the sample 35-4 presented a maximum intensity (I_{max}) at 9 sec approx. and then slowly decreased. The sample 40-5 presented I_{max} at 13 sec, maintained this value approx. until 20 sec and then decreased. Consequently, a time of 20 seconds between sips was selected, providing time enough to maintain the liking level and prevent that the evaluator's acceptance dropping below the neutral level and to obtain more homogeneous curves among participants.

2.4 Self-reported like/dislike intensity-time response curves (explicit measures)

The panel of 73 consumers evaluated the acceptance level through time using T-I data acquisition module of the software SensoMaker v1.8 (Federal University of Lavras, Brazil). On intensity scale (range 0-10, with 0= dislike and 10= like extremely), the software provided the T–I curve as well as the maximum intensity (I_{max}) and area under the curve (AUC).

Before starting the test, the participants were instructed in the evaluation software use. Each participant consumed three sips of the same sample (10 mL each), taking one sip every 20 seconds, and making a continuous rating for 60 seconds. The time axis was standardized in order to avoid that the total time differs from one participant to another, ruling out potential time-based differences. The timing of sample sips was managed by the timer on the software screen. The cursor was always visible during the continuous rating on the scale, which was anchored between 0 and 10. The specific instructions given at the subjects regarding the temporal liking task were as follow: "You will receive three cups of sample and the task is to evaluate liking through a 60 sec time period responding to the question: How do you like this beverage now? Put the entire content of the first cup of the sample in your mouth, quickly press the start button and, evaluates the level of liking using the mouse to move the cursor along line scale on the screen. When the timer indicates 20 sec, put the seconds cup of the sample in your mouth and continue the evaluation. At 40 sec, put the third cup of the sample in your mouth and continues the evaluation of liking until 60 sec".

Mineral water was used for rinsing between formulations which were served in transparent plastic containers at 15º C; however, in the 20 sec interval sip of the same sample the subjects did not rinse their mouths with mineral water. The participants evaluated the two formulations in one session. The order of formulation presentation was balanced among 73 consumers.

2.5 Facial expressions: basic emotions and action units (implicit measures)

A behavioral measure of formulation-elicited affective reactions was provided by the analysis of the facial patterns following the procedure of García-Burgos and Zamora (2013). Facial reactions were videotaped with a digital video camera (JVC GZ-MS150SU), which was located in a hole of the booth wall, directly above the computer screen and in front of the subject at a distance of 1.5 m. The illumination of the participant's face was optimized by using daylight lamps (6500 k), in addition to the ceiling lights. The participants sat on a wooden school chair and were kept from turning their head by rating the liking of the beverages by time-intensity registers on a computer screen. The cups used were transparent so that they did not interfere with the recording. In addition, the camera had face detection technology which identified people's faces following their movements and made adjustments to achieve the optimum focus, exposure and white balance. The experimenter followed the facial expressions in real time watching the camera screen without being seen by the subjects.

The video files were run through the FACET™ SDK (iMotions Inc., Cambridge Innovation Center, US). The automatic facial expression recognition software tracked and analyzed frame-by-frame (1/25 s) the intensity (as estimated by expert human coders from 0 [=absent] to 1 [=very high intensity]) of positive/negative valence (as measure of overall affection) and joy/disgust emotion (as measure most likely based on solely flavor pleasantness/ unpleasantness, respectively), as well as the probability for the presence of facial Action Units (AUs) related to specific pleasant/ unpleasant reactions (as the levels of the evidence for the specific facial muscle activations [between 0=absent and 1=strongly present] described in the Facial Action Coding System; Ekman & Friesen, 1978). On the basis of previous findings (Ekman & Friesen, 1978; Ekman, Friesen & O'Sullivan, 1988; Weiland, Ellgring & Macht, 2010), cheek raising (AU6), lip corner pulling (AU12) and lip sucking (AU28) were taken as facial movements displayed in response to a pleasant stimulus; while nose wrinkling (AU9), upper lip raising (AU10), lip corner depressing (AU15) and jaw dropping (AU26) as index of unpleasant reactions. Negative valence and disgust emotion were included in order to get a complete view of the overall hedonic reactions. Thus, the intensity of valence and basic emotions and the probability of AUs during the 1-, 5- and 10-seconds intervals after the first sip, seconds sip and third sip were calculated and transformed into mean values. The ten seconds before the first sip were used as a baseline for all the analysis. After excluding frames without facial tracking due to head movements (e.g., shaking and turning the head, head-down motions) and occlusions of the face (e.g., when hand gestures occluded parts of the face); approximately 80% of the video frames were analyzable by the software.

2.6 Data Analysis

Following the same analysis of T-I measurements that Taylor and Pangborn (1990), individual curves with I_{max} >5 (sample liked) and $I_{max} \leq 5$ (sample disliked or neutral) were separately explored. 2 Gender × 2 Samples × 3 Sip mixed-factorial ANOVAs were performed on T-I parameters, I_{max} and AUC. On the other hand, 2 Gender × 2 Sample × 3 Sip ANOVAs were performed on the intensity output of valence (positive/negative), basic emotions (joy/disgust) and the probability of AUs being present for 1-, 5- and 10-seconds periods. Gender (male vs. female) condition was considered as the between-subjects factor, and Sample (40-5 vs. 35-4) and Sip (first vs. seconds vs. third) as the within-subject factors. We used the same statistical strategy (General Linear Model procedure of PASW Statistics 18; SPSS Inc., Chicago, IL) as Rocha Parra et al. (2015) in order to reduce alternative explanations in terms of statistical bias, although the present study included more within-measurements (2 formulations × 3 sips vs. 4 formulations × 1 sip) but lower sample size (73 vs. 144 participants). The post-hoc comparisons were carried out by Tukey test. For all analyses, $p \leq .05$ was considered significant.

3. Results

3.1. Self-reported like/dislike intensity-time response curves (explicit measures)

The visual analysis of individual curves with $I_{max} > 5$ (sample liked) and $I_{max} \leq 5$ (neutral or disliked) for the sample 40-5 showed that 32 females (91.4%) and 34 males (89.5%) presented $I_{max} > 5$. Consequently, the curves of subjects with the range of Imax ≤5 (three females and four males), who also demonstrated the lowest values in the dislike range for the sample 35-4, were discarded. This selection of the curves reduces the variability and increases the consensus among participants, since only those consumers who like the drink will be considered for the analysis. In the case of the sample 35-4, visual analysis of individual curves did not show such unanimous acceptance consensus, being most of the curves close to neutral point. The average acceptance T-I curves for males and females of the two samples, during three sips, over the time course of 60 s are shown in Figure 1 and mean values of I_{max} and AUC for the three sips according to gender and samples are shown in Table 1. The differences in acceptance between samples were evident from the first to the third sip.

These visual observations were statistically confirmed through ANOVA analysis of the curve parameters.

-Figure 1 here-

The ANOVA analysis on I_{max} showed a significant main effect of Sample ($F [1, 386] = 101.39$, $p <.001$, $\eta p2 = .21$), and Sip ($F [2, 386] = 11.07$, $p <.001$, $\eta p2 = .06$). No other effects or interactions were significant. The analysis of Sip showed lesser liking scores in the first sip compared with the others two sips (ps<.05; see Table 1); as well as the higher scores for the sample 40-5 compared to 35-4. The analysis of AUC presented a significant main effect of Gender ($F [1, 386] = 12.33$, $p <.001$, $\eta p2 = .03$), Sample ($F [1, 386] = 113.66$, $p <.001$, $\eta p2 = .23$) and Sip ($F [2, 386] = 109.86$, $p <.001$, $\eta p2 = .37$). No other effects or interactions were significant. The significant effect of Gender demonstrated higher scores of self-rated liking in male compared with female participants; the analysis of Sample showed higher scores for the sample 40-5 compared to 35-4; as well as differences among the three sips, with an increasing of liking scores from the first to the last sip (ps<.05).

- Table 1 here-

3.2 Facial expressions: valence, basic emotions and action units (implicit measures)

In terms of positive valence (see Figure 2, A), unlike the 1-seconds (highest $F[2, 144] =2.22$, $p = .11$) interval, the analysis of 5-seconds and 10-seconds periods after tasting the wine samples showed a main effect of Sip ($F [2, 144] = 13.32$, $p < .001$, $\eta p2 = .16$) with higher intensity in the first sip compared to third one (ps<.05) and a Gender × Sip interaction (lower $F [2, 144] = 3.06$, $p = .05$, $\eta p2 = .04$). The analysis of the interaction showed that positive valence decreased in female from the first sip to the third one, as well as a lower score in the third sip compared to males ($ps<.05$). The analysis of negative valence (see Figure 2, B) only showed a main effect of Gender ($F [1, 72] = 5.01$, $p < .05$, $\eta p2 = .06$) during the 1-seconds interval, with greater negative valence score in females compared with males, and Sip ($F [2, 144] = 3.06$, $p = .05$, $\eta p2 = .04$) in the 5-seconds period, with a reduction from the first and seconds sips to third one. No other effects or interactions were significant in positive/negative valence (highest $F[2, 144] =2.62$, $p=.08$).

-Figure 2 here-

Concerning basic emotions (see Table 2), the analysis of joy did not reveal any significant main effects or interaction (highest $F [2, 144] = 2.64$, $p = .08$). The analysis of disgust revealed a significant main effect of Gender during the 1-seconds interval ($F[1, 72] = 3.70$, $p = .05$, $\eta p2 = .05$), with a higher intensity in females than males, and Sip during the 1-seconds, 5-seconds and 10-seconds intervals (lowest $F [2, 144] = 3.09$, $p < .05$, $\eta p2 = .04$), with higher intensity in the first sip compared to third one ($ps<.05$). No other effects or interactions were significant.

- Table 2 here-

In terms of pleasantness-related AUs (see Table 3), the analysis of AU6 revealed a significant main effect of Sip in 1-, 5- and 10-seconds periods (lowest $F [2, 144] = 3.52$, $p < .05$, $\eta p2 = .05$), showing a lower level of cheek raising during the last sip compared to seconds one ($ps<.05$). The analysis of AU12 showed a significant main effect of Sip in 5- and 10-seconds periods ($F [2, 144] = 4.71$, $p < .05$, $\eta p2 = .06$), with a decrease of lip corner pulling in the third sip compared to the first and seconds ones ($ps<.05$). No other effects or interactions involving pleasantness-related AUs were significant (highest F [2, 144] = 3.18, p = .09, $\eta p2$ = .08).

In terms of unpleasantness-related AUs (see Table 3), the analysis of AU9 and AU10 across 1-, 5- and 10-seconds periods revealed no significant effects or interactions (highest F [2, 144] = 3.20, p = .08, $\eta p2$ = .03). By contrast, the analysis of AU26 revealed a significant main effect of Sip in the 1-seconds period (F [2, 144] = 5.58, $p < .01$, $\eta p2$ = .07), showing an increment of jaw dropping from the first to the third sip; whereas the analysis of AU26 and AU15 in the 5- and 10-seconds periods revealed a significant main effect of Sip (lowest F [2, 144] = 10.33, $p < .001$, $\eta p2$ = .12) and interaction of Gender × Sip (lowest F [2, 144] = 3.60, p =.05, $\eta p2$ = .05), showing a lower lip corner depressing in females compared to males during the third sip and a higher intensity in the seconds sip compared to third one . No other effects or interactions involving unpleasantness-related AUs were significant (highest F [2, 144] = 2.94, p = .09, $\eta p2$ = .04).

- Table 3 here-

4. Discussion

The modality of multiple-sip temporal-liking (MSTL) using computerized time-intensity methods to produce like/dislike intensity-time response curves was used. This modality was combined with implicit taste reactivity methodology using facial pattern expressions. Both methodologies, explicit (i.e., self-rated liking via MSTL) and implicit measure (i.e., taste reactivity via facial pattern expressions) hedonic response. These hedonic responses were examined during consumption of a new red wine-based powder beverage.

The results of the present paper show that MSTL modality allows seeing temporal changes in the acceptance of the beverage. Parameters analyzed (I_{max} and AUC) in self-reported response curves presented variation through successive sips. The self-rated liking increased from the first sip to the third.

In the same way, the implicit measures via facial expressions also showed a change over time during successive sips. In this case negative valence, basic emotion of disgust and unpleasantness-related AUs (AU 26 and AU 15) showed a decrease from the first sip to the third one. In addition, the same behavior (but with less intensity) was presented in positive valence and pleasantness-related AUs (AU6 and AU12). This is supported by the findings of Horio (2003), Weilland et al. (2010), de Wijk et al. (2012), and Danner et al. (2013) who also found that negative facial reactions were significantly more intense than positive ones.

On the other hand, the present wine-based beverage reproduced the gender differences in sensory perception of regular red wine as it has been previously reported (Atkin, Nowak & Garcia, 2007; Bruwer, 2007). Interesting changes were observed in women's liking patterns, those who showed greater negative valence score and higher intensity of disgust during the very first contact with the beverage (in the first sip and 1-seconds interval), and greater reduction in positive valence over time (in the third sip and 10-seconds period) this can be seen in Fig. 2. Therefore, our findings support that acceptability varies during the consumption experience, and multiple-sip methodology allows to identify at what time the consumer acceptance changes in a more realistic way.

Rocha Parra et al. (2015) examined the acceptance of the same red wine-based powder beverage, but using a simple-sip and single-point measurements. They found divergence in acceptance by gender only after using a double scale "confirmation" strategy. It consisted of using a second scale to double check consumer evaluations, in which first a 9-

point category scale and then a Visual Analogue Scale (VAS) were applied in order to confirm the participants' perceptions about this new beverage. By contrast, clear gender differences in acceptance appeared when the hedonic reaction was monitored dynamically using cumulative measurements (such as the area under the liking time curve), after multiples sips (as in the case of positive valence), and with measurements at different durations (5- and 10-seconds periods in the case of AU15 and AU26). These changes in acceptance may be associated with small differences in the sensory profiles of different products and they only become noticeable after repeated tasting (Köster et al., 2002; Stein et al., 2003; Zandstra et al., 2004; Zorn et al., 2014).

Different methodologies have been adapted to measure linking over time. Kuesten et al. (2013) applied multi-attribute time–intensity (MATI) to evaluate both intensity and linking attributes. Delarue and Loescher (2004) studied the dynamics of food preferences by means of hedonic tests with imposed duration (linking evaluation every 1, 5 and 30 minutes), and Sudre et al. (2012) adapted TDS-methodology to investigate the temporal aspects of hedonic response. However, these methodological adaptations lack the continuous nature of time-intensity registers; and they were made using a unique event each measure (one sip). Thomas et al. (2015) made some modifications to capture the continuous nature of the hedonic response, but also used a single sip analysis to make the evaluation. Regarding multiple sip methodology, Methven et. al. (2010) adapted boredom test to investigate linking over the time. The inherent nature of this method made it possible to investigate the ONS (Oral nutrition supplements) evaluated during successive sips.

The present paper is the first work that addresses the specific issue of multiple sips applied to food related facial analysis. Multiple-sip assessment offers much more information than one sip because each sip constitutes an independent event. Moreover, the use of the two approaches (explicit and implicit measures) allows observing different dynamic responses as three successive stimuli were evaluated.

Limitations of the analysis of temporal liking scores should be also considered in order to provide more accurate information about hedonic processes underlying product acceptance and preferences. For example, cumulative measurements as area under the curve of liking ratings or of the automated facial expression output, offers a global picture view of affective state and temporal changes (several sips), but they do not recognize the temporal dominance of emotions and the time course or dynamics of emotion. Also, rating liking continuously during and following taste-related emotion elicitation could interfere with emotion experience.

Furthermore, it will be necessary to extend the present study to other products in order to confirm whether the observed gender differences are really related to the product, or could be a more general 'gender-related' difference in dynamics of acceptance. The overall mean in each basic emotions and action units over 1, 5 or 10 seconds duration allows the simultaneous evaluation of multiple emotions of positive or negative valence. It will be important to develop methodology to assess acceptability trends and affective responses in a more time sensitive manner; such as using time series analysis of emotions from facial expression (Leitch et al., 2015). Another improvement could be the use of a higher number of sips, larger amounts, and a larger duration of the liking evaluation.

Conclusions

The present work revealed that the multiple sip methodology allowed observing changes in acceptance of the studied beverage, through successive sips using explicit and implicit measures. Moreover, multiple-sip offers more information than one sip because each sip constitutes an independent event. Both measures (explicit and implicit) show differences between genders, as shown by a greater area under the liking-time curve as well as lesser score of negative valence and disgust emotion in male participants. The overall mean in each basic emotions and action units over 1, 5 or 10 seconds durations allows the simultaneous evaluation of multiple emotions of positive or negative valence. However, negative facial reactions are greater than the positive facial reactions in intensity.

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Figure captions

Figure 1. Time-Intensity curves for the degree of liking of two different powder beverage samples (40-5 and 35-4) during 60 sec after the first (0 sec), second (20 sec) and third (40 sec) sip. The averaged data are split by gender groups.

Figure 2. Effect of the first, second and third sip on intensity of positive (A; pleasant) and negative (B; unpleasant) valence for males and females during the 1-, 5- and 10-seconds intervals for two different powder beverage samples (40-5 and 35-4).